2014•2015
FACULTEIT GENEESKUNDE EN LEVENSWETENSCHAPPEN
master in de revalidatiewetenschappen en de kinesitherapie

Masterproef

Correlation between nutritional status and development of children up to 5 years of age, living in extreme poverty

Promotor :
Prof. dr. Marita GRANITZER

Copromotor :
De heer Berhanu Nigussie WORKU

Anneleen Peeters , Loes Vandersmissen
Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie

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Designed according to the author guidelines of “Child Development”
http://www.srcd.org/publications/child-development

Acknowledgement

A Master thesis must be conducted to successfully complete the second Master degree in Rehabilitation Sciences and Physiotherapy. We had the opportunity and the honour to do our writing in Jimma, Ethiopia. We would like to express our gratitude to some important people who supported our project. Firstly, we would like to thank our promoter Prof. Dr. Marita Granitzer, for providing us with this amazing opportunity and for giving us support and advice throughout the making of this thesis. Secondly, we would like to thank our co-promoter Drs Berhanu Nigussie Worku for providing us with the data and afterwards helping us with processing this data. He was also there for us when we experienced some difficulties during our stay in Jimma. We are grateful that we were able to do some voluntary work as physiotherapists at the Mission of Charity Hospital in Jimma. Thanks to the hardworking staff many of the poorest people are able to get medical attention in a clean and safe environment. We have learned a lot and hope to have been able to contribute to the knowledge of the physiotherapists that are working there. At the hospital we came in contact with extreme poverty and disease, but we also saw the hope that lives there. At the Mission of Charity and at the Pediatrics Department of the University Hospital, we came in contact with the subjects of our thesis, malnourished children. This way our thesis became real, tangible and we feel that this is a real addition to our work. We would also like to thank Dr. Mekitie Wondafrash, who helped us with his nutritional expertise.

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Kuringen & Nieuwerkerken, 9 March 2015 A.P. & L.V.

Research context

The poorest 20 percent of the world's children are twice as likely as the richest 20 percent to be stunted by poor nutrition and to die before their fifth birthday. Children in rural areas are at a disadvantage compared to those who live in urban areas (UNICEF, 2015).

Worldwide prevalence of undernutrition continues to decrease due to many attempts made to combat it, such as the Millenium Developmental Goals. But inadequate nourishment still remains a primary cause of illness and death in children (UNICEF, 2015). Worldwide the cause of almost 50% of all deaths in children below the age of 5 years can be traced back to undernutrition (UNICEF, 2014). Ethiopia is one of these countries with high levels of child undernutrition and mortality. But it is worth mentioning that in 2013, Ethiopia achieved the child survival millennium developmental goal by reducing deaths among under-5-year-olds by two thirds. Progression continues to be made, as the number of under-5 child deaths fell to 64 per 1000 live births in October 2014*. In 1990, 1 in 5 Ethiopian children could be expected to die before reaching the age of 5. Today, the figure is closer to 1 in 15* (KesetebirhaneAdmasu, and Salama, 2014).

This thesis is part of the "Child health and nutrition" project of the Institutional University Cooperation Jimma University (IUC-JU), which is a long-term collaboration between the Jimma University of Ethiopia, the University of Hasselt, the University of Gent and the department of PXL-Healthcare. The IUC-JU project of "Child health and nutrition" aims at improving child growth and development. These goals are attempted to be accomplished by decentralising the management of malnutrition to primary services, augmenting the complementary feeding for young children and improved household food security. For this thesis, recruiting and data acquisition was completed by Drs. Berhanu Worku Nigussie and his team. Based on this data, a research design was composed by Anneleen Peeters and Loes Vandersmissen in discussion with Prof. dr. Marita Granitzer and Drs. Berhanu Nigussie Worku. Data entry and data analysis were executed by Peeters Anneleen and Vandersmissen Loes, in cooperation with Drs.Berhanu Nigussie Worku. Academic writing was performed completely by Peeters Anneleen and Vandersmissen Loes.

References Research Context

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Operational Definitions and Abbreviations

Operational Definitions

Kebele: Refers to the smallest administrative unit in the Ethiopian government administration system.
Kwashiorkor: A specific type of wasting, always classified as severe acute malnutrition. Typical is bilateral pitting oedema in legs and feet. When no steps are taken, it spreads to the rest of the body (UNICEF, 2009/2010).
Malnutrition: Insufficient quantities of nutrients or wrong proportions of nutrients in a diet. Even though it also refers to overnutrition, it is often used as an alternative to the term undernutrition (UNICEF, 2006a). ***In this thesis it is used interchangeably with undernutrition.***
Marasmus: A specific type of wasting. The body breaks down fat and muscle in order to produce energy, which results in a very thin and wasted physique (UNICEF, 2009/2010).
Oedema: The buildup of fluid in body tissues that results from severe nutritional insufficiency (UNICEF, 2009/2010).
Stunting: Chronic malnutrition, low height/length-for-age, below -2 standard deviations of the median (UNICEF, 2013).
Undernutrition: Deficient food consumption and infectious diseases together cause undernourishment. Low weight-for-age, low height/length-for-age and micronutrient deficiencies are included in this term (UNICEF, 2006b).
Underweight: Combination acute and chronic malnutrition, low weight-for-age, below -2 SD of the median (WHO, 2014b).
Wasting: Acute malnutrition, low weight-for-height/length, below -2 SD of the median (UNICEF, 2013).
Z-score: Number that indicates how many standard deviations a data point differs from the reference mean value. In this study the z-score indicates how many standard deviations a child differs from the WHO child growth standards.

Abbreviations

SD: Standard Deviation
UNICEF: United Nations International Children's Emergency Fund
WHO: World Health Organisation
H/LAZ: Height/length for age z-score
WH/LZ: Weight for height/length z-score
WAZ: Weight for age z-score

Content

Abstract

In order to identify possible correlations between developmental skills and types of undernutrition in children living in extreme poverty, 819 children aging between 4.87 and 60.90 months were examined. Developmental status was assessed using the Denver-II-Jimma, nutritional status was determined using anthropometric measurements. Multiple linear regression was used to examine possible correlations between different types of malnutrition and developmental skills. Significant predictors ($p < .05$) for the developmental domains of the Denver-II-Jimma were: stunting and wasting for social-personal; stunting, age in months, and wasting for language; age in months, stunting and underweight for fine motor-adaptive; age in months, stunting and underweight for gross motor. The correlations between nutritional status and the domains of the Denver II-Jimma were always negative.

A child's developmental potential is highly sensitive to external influences such as extreme poverty, maternal depression, impaired intrauterine growth, low birth weight, genetics and nutrition (Ahmed, Hossain, and Sanin, 2012; Grantham-McGregor et al., 2007; Prado, and Dewey, 2014). Nutrition deficiencies have been shown to cause neurological changes on both morphological and functional levels (Atalabi, Lagunju, Tongo, and Akinyinka, 2010; Benitez-Bribiesca, De la Rosa-Alvarez, and Mansilla-Olivares, 1999; Cordero et al., 1993; Durmaz, Karagol, Deda, and Onal, 1999; El-Sherif, Babrs, and Ismail, 2012; Gunston, Burkimsher, Malan, and Sive, 1992; Hazin, Alves, and Falbo, 2007; Househam, 1991; Househam, and de Villiers, 1987; Odabas et al., 2005; Tamer, Misra, and Jaiswal, 1997).

The long-term effects of early childhood undernutrition have been studied quite extensively and include impaired gross and fine motor skills such as poorer endurance, lower flexibility and lesser scores on rapid sequence movements (Galler, Ramsey, Salt, and Archer, 1987; Kulkarni et al., 2012; Paiva et al., 2012), cognitive impairments at a later age, for example lowered attention spans, impaired language skills and lower IQ scores (Kar, Rao, and Chandramouli, 2008; Rose, 1994; Waber et al., 2014). Other recurring findings are behavioural problems such as apathy and lack of exploration and interaction (Galler, and Ramsey, 1989; Galler, Bryce, Waber, Hock, et al., 2012; Galler, Ramsey, Solimano, and Lowell, 1983) and poorer school results (Bisset, Foumier, Pagani, and Janosz, 2013; Ivanovic et al., 2000; Shariff, Bond, and Johnson, 2000; Waber et al., 2014). These effects have been found to continue into adulthood (Galler et al., 1987; Galler, Bryce, Waber, et al., 2012; Ivanovic et al., 2000; Waber et al., 2014). A significantly elevated prevalence of depressive symptoms was observed in teenagers malnourished in early life (Galler et al., 2010) and a study by Waber et al. (2011) found an indirect link between malnutrition and depression through standard of living and cognitive measures. Undernutrition in early life has a significant effect on socioeconomic outcomes in adulthood, mostly due to cognitive impairment. Through this mechanism lack of nutrition perpetuates poverty and has detrimental effects on society and the economy (Waber et al., 2014).

Undernutrition is the result of inadequate food consumption and recurring infectious diseases. It includes micronutrient deficiency diseases, stunting, wasting and underweight (UNICEF, 2006b). Micronutrients are vitamins and minerals. They are essential for metabolic processes in the human body. Common deficiencies are lack of iron, vitamin A, iodine or zinc (WHO, World Food Program, and UNICEF, 2006). Micronutrients are not further discussed in this article and undernutrition will be used exclusively to refer to stunting, wasting and underweight.

Stunting, or a child that is too short for its age, occurs when there is a chronic lack of nutrition. Height/length for age will fall below more than two standard deviations of the median of a reference population. Wasting is caused by acute starvation and is defined as low weight for height/length, though it can also result from chronic conditions. The child's weight for height/length will be lower than two standard deviations of the median determined by a reference population (WHO, 1997; UNICEF, 2014).

Two specific kinds of acute malnutrition or wasting are marasmus and kwashiorkor. In marasmus, the body does not have access to an adequate amount of energy resources and starts to break down its own tissue (fat and muscle). It becomes wasted and skeletal (UNICEF, 2009/2010).

Kwashiorkor is a dangerous condition and always classified as severe acute malnutrition. Bilateral pitting oedema can be seen in the child's legs and feet. As kwashiorkor progresses further, the oedema spreads to the arms, hands and face. There is also discoloration and shedding of the skin, called dermatosis (UNICEF, 2009/2010).

Worldwide prevalence is as follows; 25%, 8% and 15% of children under 59 months are respectively stunted, wasted and/or underweight. Children in the least developed countries are even more at risk and numbers increase up to 37%, 9% and 22% for stunting, wasting and underweight respectively (UNICEF, 2015).

Rehabilitation limited to nutritional supplementation has turned out to be inadequate to help previously malnourished children in achieving their full cognitive potential (Nahar et al., 2012). In order to provide efficient care, it is necessary to investigate the particular correlations between different developmental skills and types of undernutrition.

This study aims to identify those possible differences on child development by processing previously collected data on children up to 5 years of age, living in extreme poverty in the Jimma region of Ethiopia, suffering from stunting, wasting and underweight. For this purpose the hypotheses are formulated. (1) Nutritional status will have a significant negative effect on developmental status of children, up to 5 years old, living in extreme poverty. (2) Within the different types of undernutrition stunting will have the biggest effect on developmental status. (3) Gender will significantly affect developmental status. (4) Age in months will significantly affect developmental status.

Materials and methods

Participants and Sampling Technique

A total of 819 children, aging up to 5 years old and living in extreme poverty in the Jimma region of Ethiopia, took part in this study. Characteristics of the participants can be found in table 1 in the results section.

The participating children were already registered as living in extreme poverty or were registered by the Women's and Children's Affairs (WCA) Bureau and by Kebele administrators. In order to ensure an objective selection and registration of the children as living in extreme poverty by the WCA and the Kebeles, their living situations were observed and informal interviews were carried out with caregivers.

Inclusion Criteria

- Children living in the town of Jimma, aging up to 5 years.
- Children living in extreme poverty, registered by the WCA Bureau and Kebele administrations. Children were confirmed as living in extreme poverty by the researchers.
- Children in extreme poverty, living with a single parent, both parents terminally ill, poor relatives or significant others, or with foster mothers.

Exclusion Criteria

- Children with hearing and visual impairments.
- Children with severe mental retardation.
- Children with apparent physical disability which hinders mobility and thus deters testing with the Denver-II Jimma.
- Children suffering from severe acute malnutrition (SAM).

Procedure

Materials

The primary outcome measured was developmental status, which was assessed using the Denver-II-Jimma test. The Denver-II-Jimma test is a culturally modified version of the Denver-II (Frankenburg, Dodds, Archer, Shapiro, and Bresnick, 1992) made specifically to evaluate development in 0 to 6-year-olds living in Jimma, a region of South-West Ethiopia. The test evaluates the performance of the child on different tasks and makes it possible to compare with children of the same age.

The test is divided into four developmental domains, with 126 test items in total and takes about 20 minutes per child. The domains that were assessed are: fine motor-adaptive development, gross motor development, language development and personal-social development. To adapt the Denver-II test, one item was added in the personal-social domain and 40 of the Denver-II test items were modified. Of these 40 items, 18 items of the personal-social domain, 12 items of the language domain and 10 items of the fine motor-adaptive domain were adapted. Some materials of the original test kit were modified; a cereal was replaced with a coffee bean, “blue” and “yellow’ cubes were substituted with “black” and “white” cubes and the pink doll was replaced with a brown one.

The personal-social items score on how the children have attention for their personal needs and how they get along with people. Eye-hand coordination, problem solving, and manipulation of small objects are evaluated by the fine motor-adaptive items. The language aspect of the Denver-II test concentrates on the production of sounds, the hearing, understanding, and use of language. Motor control, sitting, jumping, walking, and overall movement of the large muscles were scored using the gross motor items of the test.

The secondary outcomes are growth and nutritional status. Body height/length and weight are used as indicators of growth. The children wore no shoes and only light clothing during the anthropometric measurements. Both measurements were performed three times in a row and the mean of these three measurements was calculated. Body length of children younger than 2 years was measured lying down, on a measuring board. Older children were measured standing upright by a portable stadiometer. Body weight was measured by a calibrated electronic weighing scale. Young children not able to lay still were measured with the mother and afterwards the weight of the mother was measured and subtracted from the total weight. Nutritional status of all children living in extreme poverty was determined using z-scores of weight-for-height/length (WFH/L), weight-for-age (WFA) and height/length-for-age (H/LFA).

Research design

To identify the possible correlations between different developmental skills and types of undernutrition in Jimma children, aging up to 5 years and living in extreme poverty, a cross sectional study was performed. Developmental profile and nutritional status of 819 children living in extreme poverty were assessed and assigned to one of four nutritional groups, according to the classification of WHO (WHO, 1997). The developmental profiles of different nutritional groups were then compared amongst each other.

Procedure of data collection

Two trained testers, both speaking Afan Oromo and Amharic and one supervisor performed the tests and measures of the primary and secondary outcomes. These were all nurses, specially selected for their childfriendly attitude. Data collection was started once ethical permission was given by the University of Hasselt (UHasselt) and Jimma University (JU) and the Bureau of Women’s and Children Affairs (WCA) of Jimma town gave its consent to access the children. The Ethical Clearance Board of the Jimma University has approved the protocol on 13/02/2013 (reference number: RPGC/36/2013). Testing of a child was conducted in the following order: first the Denver-II-Jimma and then the anthropometric measurements. We will explain the procedures in more depth.

The Denver-II Jimma must be administered in accordance to the standardized procedures described in the Denver-II manual. It is important to create a comfortable environment for child and caregiver, so the child can perform naturally. Before starting the test, the tester will calculate the child's test age based on the child's age. The tester will also explain that the Denver-II-Jimma defines the child's current developmental status and that the child is not expected to score on all the test items. During the Denver-II Jimma testing there was no fixed sequence used of the different developmental domains; the order was changed according to the alertness of the child. The observation of the "free" activity of the child is also part of the evaluation.

The amount of test items differs with the child's age and abilities, it is also determined by the test goal: identifying the child's relative strength or developmental delays. Position with reference to the age line allows for individual test item scores to be interpreted. Relative strength can be determined by administering items closest to and right to the age line until seven failures were measured after the last 'pass' (Gladstone et al., 2010). Developmental delay is determined by administering at least three items closest to and left to the age line. Every time the child is incapable of achieving an item (fail, refuse, no opportunity) or if the item crosses the age line, supplementary items to the left in the appropriate sector have to be administered until the child passes three items (Frankenburg, Dodds, Archer, Shapiro, and Bresnick, 1992).

Before administering the test, the child's current age was determined by calculating the difference between the test date and the child's birth date. Each item's score had to be documented on the bar near the 50% hatch mark. Items of the Denver-II-Jimma draft 3 were scored as a "Pass", "Fail", "Refusal" or "No opportunity". A "Pass" was scored if the child was successful at performing the item or if it was reported by the caregiver that the child did the item. A "Fail" was scored if the child did not complete the item or if it was reported by the caregiver that the child did not do the item. Because it was possible that a child was not allowed to perform a certain test item or refused to attempt it, a "No opportunity" or "Refusal" could be scored. It is possible to reduce the amount of refusals by telling the child to do something rather than asking them. If an item was reported by the caregiver, it was illustrated by marking "R" in the item bars on the test form and behind the item names in the administration directions. Three trials may be used to perform the items, before 'Fail' is scored.

After finishing the Denver-II Jimma test, the "Test Behavior" rating scale was used to compare the previous behaviour of the child with the performance of the child during the test. It is possible that the child is ill, tired, upset or hungry, which may have implications on the performance of the child. Because of this, it is important to ask the caregiver if the test performance of the child was typical for his ability at other times. If not, the test should take place another day and at a time when the child is expected to be more willing.

Results from 488 children (aging 4-66 months) indicated that the Denver-II-Jimma draft 3 is reliable to be used for developmental screening of children in Jimma, Ethiopia. Inter-rater reliability was excellent and intra-rater reliability was moderate to excellent (Bielen, Orye, Granitzer, Simons, and Gemechu, 2012).

Statistical analysis

In order to explore if there was a significant difference in the developmental outcome measures of the four domains of the Denver-II-Jimma between children with different types of malnutrition and normally nourished children, multiple regression was used.

Correlations between the developmental outcome measures of every domain, gender, and age were analysed for all children. To visualise distribution of the Denver-II-Jimma outcome measures when taking into account age, gender, HAZ, WAZ, and WHZ scatterplots were made.

Nutritional status of all children living in extreme poverty was determined using z-scores of weight-for-height/length (WFH/L), weight-for-age (WFA) and height/length-for-age (H/LFA). Z-scores indicate how many standard deviations (SD) the WFH/L, WFA or H/LFA differ from the reference values that have been set by the WHO child growth standards. Z-score is a valid and reliable method to compare with the standard reference (Centers for Disease Control and Prevention, and World Food Programme, 2005). The WHO child growth standards are a reliable tool to compare growth patterns and make estimates of malnutrition (WHO, 2006). The z-scores for WFH/L, WFA, and H/LFA were calculated using WHO Anthro (version 3.2.2, January 2011). Because WHO Anthro is valid for children younger than 61 months, and all the children in this study were younger than 61 months, we only used WHO Anthro, and not Anthro Plus. After computing z-scores, children were classified according to nutritional status using the WHO classification (WHO, 1997). The cut-off points for moderate and severe wasting, stunting, and underweight are < -2 SD and < -3 SD, respectively.

The Statistical Package for Social Sciences (SPSS) was used for statistical analysis, version 22. The level of statistical significance was set at $p<.05$.

Results

Nutritional status

A total of 819 children (398 girls and 421 boys), between 4.87 and 60.90 months of age, were assessed for nutritional status and developmental profile. Mean age (±SD), weight (±SD), and height/length (±SD) of the children living in extreme poverty were 30.83 months (±16.06), 11.47 kg (±2.98) and 84.48 cm (±11.96) respectively.

Table 1 presents the percentages of the different nutritional states of the children living in extreme poverty. In total, 340 out of 819 children were moderately or severely malnourished: 39.7% were stunted, 16.5% were underweight and 3.3 % suffered from wasting. Of these malnourished children, 37.97% show developmental delays on the personal-social domain (n=311), 38.1% on the language domain (n=312), 14.29% on the fine motor-adaptive domain (n=117) and 19.29% on the gross motor domain (n=158). Figure 1 shows the performance ratios on each developmental domain in correlation with the age in months. These plots show more variation in scores for children at younger ages, than for children at an older age.

Table 1. *Nutritional status of children living in extreme poverty based on the WHO standards*

Nutritional status			**Gender**	
			Female	**Male**
Weight-for-length N=(%)	≥-2 SD No wasting	792 (96.7%)	389 (49.1%)	403 (50.9%)
	< -2 SD Moderate wasting	19 (2.3%)	7 (36.8%)	12 (63.2%)
	< -3 SD Severe wasting	8 (1.0%)	2 (25.0%)	6 (75.0%)
Length-for-age N=(%)	≥-2 SD No stunting	494 (60.3%)	248 (50.2%)	246 (49.8%)
	< -2 SD Moderate stunting	213 (26.0%)	105 (49.3%)	108 (50.7%)
	< -3 SD Severe stunting	112 (13.7%)	45 (40.2%)	67 (59.8%)
Weight-for-age N=(%)	≥-2 SD No underweight	684 (83.5%)	342 (50.0%)	342 (50.0%)
	< -2 SD Moderate underweight	99 (12.1%)	46 (46.5%)	53 (53.5%)
	< -3 SD Severe underweight	36 (4.4%)	10 (27.8%)	26 (72.2%)

N= Number of children

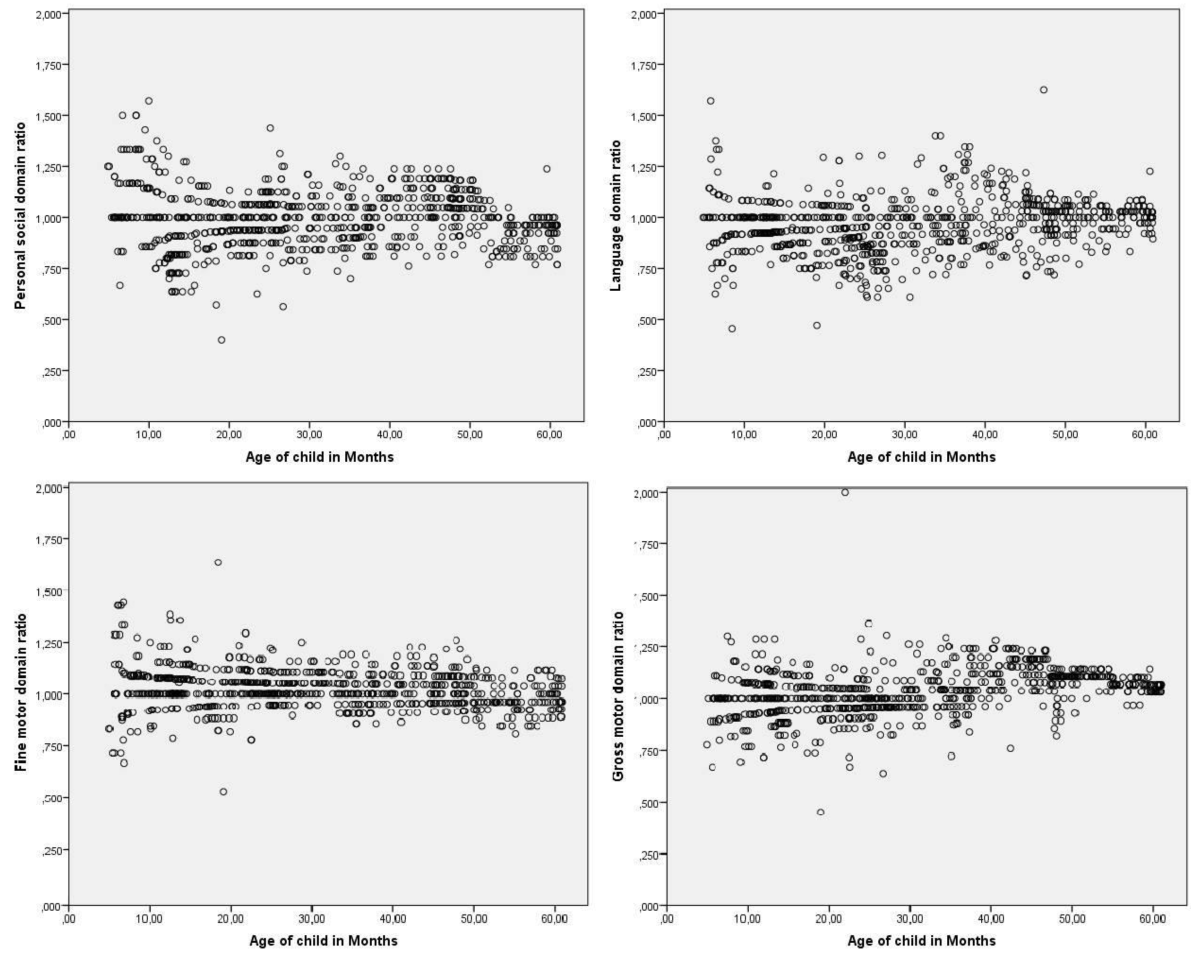

Figure 1. The performance ratios of the children living in extreme poverty (N=819) on each domain of the Denver-II-Jimma in correlation with the age in months.

Multiple linear regression was used to determine if there are correlations between the different types of malnutrition and developmental skills, as measured by the Denver II-Jimma. Before conducting the statistical calculations, assumptions for multiple linear regression were examined and met. No multicollinearity was present, with high tolerance scores (>.2) and VIF scores well below 10. Exact numbers can be found in Table 2. Histograms for the residuals of the dependent variables were all normally distributed, linearity, independence of errors and homoscedasticity were examined through scatterplots. These scatterplots showed a constant variance with every value of the predictor variables and no correlations, nor patterns of the residuals. Predictor variables were entered using Stepwise multiple regression. Correlations between the different types of malnutrition and developmental skills were examined.

Table 2. *Multicollinearity assumption of the independent variables for each developmental domain.*

	Personal-social		Language		Fine Motor		Gross Motor	
Independent variable	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Stunting	.769	1.301	.769	1.301	.769	1.301	.769	1.301
Underweight	.674	1.483	.74	1.483	.674	1.483	.674	1.483
Wasting	.846	1.182	.846	1.182	.846	1.182	.846	1.182
Gender	.994	1.006	.994	1.006	.994	1.006	.994	1.006
Age in months	.979	1.021	.979	1.021	.979	1.021	.979	1.021

Personal-social domain

For the prediction of the personal-social domain of the Denver II-Jimma stunting, wasting, underweight, age in months and gender were entered into the regression analysis. The following predictors remained significant in the model: stunting and wasting ($R^2 = .028$, $F (2, 816) = 11.783$, $p < .001$). Using the Pearson's Bivariate Correlation, we found that the correlation between the personal-social domain and independent variables stunting and wasting was negative. Underweight, gender and age in months were not significant.

Language domain

For the prediction of the language domain of the Denver II-Jimma stunting, wasting, underweight, age in months and gender were entered into the regression analysis. Three significant predictors remained: stunting, age in months and wasting ($R^2 = .075$, $F (3, 815) = 22.174$, $p < .001$). Using the Pearson's Bivariate Correlation, we found that the correlation between the language domain and independent variables stunting and wasting was negative, while the correlation between the language domain and age in months was positive. Underweight and gender were excluded.

Fine motor-adaptive domain

For the prediction of fine motor-adaptive domain of the Denver II-Jimma stunting, wasting, underweight, age in months and gender were entered into the regression analysis. The following predictors were significant: age in months, stunting and underweight ($R^2 = .061$, $F (3, 815) = 17.70$, $p < .001$). Using the Pearson's Bivariate Correlation, we found that the correlation between the fine motor-adaptive domain and independent variables stunting, underweight and age in months was negative. Wasting and gender were not significant.

Gross motor domain

For the prediction of the gross motor domain of the Denver II-Jimma stunting, wasting, underweight, age in months and gender were entered into the regression analysis. Age in months, stunting and underweight predicted the gross motor domain ($R^2 = .212$, $F (3,815) = 72.88$, $p < .001$). Using the Pearson's Bivariate Correlation, we found that the correlation between the gross motor domain and independent variables stunting and underweight was negative, while the correlation between the gross motor domain and age in months was positive. Wasting and gender were excluded.

Discussion

This study sought to examine if there are potential correlations between different developmental skills and types of undernutrition in Jimma children aging 5 years or younger, living in extreme poverty. Nutritional status of 819 children living in extreme poverty was assessed and each child was assigned to one of three nutritional groups, according to the classification of WHO (WHO, 1997). The developmental profiles of the different nutritional groups were evaluated and then compared amongst each other. The study is one of the few attempts to bring three different kinds of malnutrition in relation with their development.

The outcomes show that undernutrition has a statistically significant negative correlation with each of the four domains of the Denver II-Jimma. Stunting has been found to consistently affect all four developmental domains. Underweight has a significant effect on the fine motor-adaptive and gross motor domains. Wasting has a significant effect on personal-social skills and language. Gender was not significantly correlated with any of the four developmental domains, while age was correlated with all domains except personal-social development.

Developmental delays in undernourished children are sometimes attributed to factors such as energy conservation, apathy and lack of exploration (Meeks Gardener, Grantham-McGregor, Himes, & Chang, 1999; Walker et al., 2007). Our previously conducted literature search revealed marked neural changes in wasted children on both morphological and functional levels (Atalabi, Lagunju, Tongo, and Akinyinka, 2010; Benitez-Bribiesca, De la Rosa-Alvarez, and Mansilla-Olivares, 1999; Cordero et al., 1993; Durmaz, Karagol, Deda, and Onal, 1999; El-Sherif, Babrs, and Ismail, 2012; Gunston, Burkimsher, Malan, and Sive, 1992; Hazin, Alves, and Falbo, 2007; Househam, 1991; Househam, and de Villiers, 1987; Odabas et al., 2005; Tamer, Misra, and Jaiswal, 1997). These neural changes, which include cerebral atrophy, deficient dendrites, and impaired neural communication, may partly explain the negative correlation we found between wasting and child development and, possibly, the negative correlation between the other phenotypes of malnutrition and child development.

Undernutrition and development

Since different studies use different approaches, results cannot be compared perfectly. Some studies, for example, do not differentiate between fine and gross motor. One thing is certain: there is an obvious negative correlation between undernutrition and child development, as was hypothesised . A study by Franssen E. (2013) found that malnourished children scored less on the Denver II-Jimma than normally nourished children throughout all four domains. Kulkarni et al. (2012) reports a 2.4 to 3.7 month lag in the median age for the achievement of motor milestones in malnourished Vietnamese preschool children, aging 5 to 18 months. Their cognitive abilities (mental age and language skills) were also poorer (Nassar et al., 2012). Sandjaja et al. (2013) found that school-aged children with stunting and underweight had a higher chance of having a below-average to low nonverbal IQ (IQ less than 89). Similarly, Park, Bothe, Holsinger, Kirchner, Olnes, and Mandalakas (2010) found that underweight and wasting negatively affected indicators of cognitive development and indicators of physical skill development in internationally adopted children under 42 months.

As we hypothesised, stunting has the largest effect on developmental status compared to the other nutritional phenotypes. Hadley, C., Tegegn, A., Tessema, F., Asefa, M., and, Galea, S. (2008) documented that stunted children (3 - 24 month olds) in Ethiopia achieved lower developmental scores, but only the gross motor subscale showed a significant decrease. Other studies report significant lower verbal vocabulary scores (Crookston et al., 2010), reduced activity levels and motor skills (Olney et al., 2009; Wu et al., 2010). A study investigating 5 year olds, who had recovered from stunting, with the Revised-Denver Prescreening Developmental Questionnaire and the Vineland Social Maturity Scale found little effect of stunting on daily living skills. However, fine motor skills and cognitive functioning are significantly worse in stunted children (Casale, Desmond, and Richter, 2014).

Gender

Contrary to what we expected, gender was not significantly correlated with any of the four domains of the Denver II-Jimma. A study from Shahshahani, Vameghi, Azari, Sajedi, and Kazemnejad (2010) found similar results. But a study from Durmazlar, Ozturk, Ural, Karaagaoglu, and Anlar (1998) found minor differences in the performance of boys and girls in an inconsistent pattern and Lejarraga et al. (2002) showed that females scored better on some developmental items of the Denver II. A possible explanation of inconsistencies regarding gender influences is the fact that in our study we considered the performance in each domain as a whole, we did not take into account the results of each separate test item. Thus potential differences in gender for each domain might be compensated as a result. For example, girls might achieve higher scores on certain test items, while boys score better than them on others. This difference might not be visible in the total domain performance.

Age

As was hypothesised, age in months had a significant influence on developmental status. But we found no significant correlation with the personal-social domain of the Denver II-Jimma. A positive relation between age in months and the language and the gross motor domain was observed, indicating that, for these domains, there is an age-related improvement of the developmental outcome. Contrary to this, age in months was negatively correlated with fine motor, as can be clearly seen on the scatterplot. For a population of only normally nourished children, there shouldn’t be an age-related relation with the developmental domains because the Denver-II-Jimma takes into account age categories.

Jeharsae, Sangthong, Wichaidit and Chongsuvivatwong (2013) found no significant relation of the different phenotypes of undernutrition with age or sex in 1-5 year olds in Thailand. In the older age groups a higher delay in development was noticed using the Denver II. Fine motor and language development tended to be delayed more often, while gross motor was generally normal. Personal-social developmental problems were more prevalent in children between the ages of 23 and 47 months. Kar et al. (2008) also found that development of cognitive processes seems influenced by nutritional status, as well as age. They found an age related improvement on verbal comprehension tests, tests of visual perception and of attention in children (5 to10 years old). Yet the malnourished children still performed deficiently when compared to the performance of normally nourished children.

Long term effects and rehabilitation

The impact of moderate to severe malnutrition continuing on through childhood, adolescence and even adulthood is significant. Mostly through cognitive impairment, undernutrition in early life even significantly lowered socioeconomical outcomes in adults (Galler, Bryce, Waber, Zichlin, et al., 2012). Early childhood malnutrition is found to affect school performance in primary school children (Hall et al.,2001; Ivanovic et al., 2000; Shariff et al.,2000). Even when a successful rehabilitation of physical growth took place, higher incidences of impaired IQ and even self-reported behavioural problems remain present (Waber et al., 2014). Sokolovic et al. (2014) found that, in the age group of 6 to 12 years, a six month nutritional treatment was not sufficient to reverse the effects of stunting on poor cognitive ability. Likewise a study by Chang, Walker, Grantham-McGregor, and Powell (2010) reports that 11 to 12 year old children, who recovered from early childhood stunting, still show significantly poorer fine motor skills, even though these children received psychosocial stimulation along with their nutritional rehabilitation when they were between the ages of 9 to 24 months.

Interestingly, some studies do report an improvement of specific skills with specific treatment, so there seem to be inconsistent findings. Psychosocial stimulation combined with nutritional rehabilitation of severely malnourished children can improve both child growth and psychosocial development (Grantham-McGregor, Powell, Walker, and Himes, 1991; Nahar et al., 2009). A rapid increase in physical activity in Ethiopian children (6 months to 14 years old) with severe acute malnutrition was reported after rehabilitation according to the WHO guidelines. Physical activity appears to be an earlier indicator for successful rehabilitation than weight gain (Faurholt-Jepsen et al., 2014). Crookston et al. (2010) observed that children who recovered from stunting in infancy were likely to experience catch-up growth and show no differences in development compared to healthy children.

Other variables

In our study we examined the effects of nutritional status, gender and age on child development. No correlations were found between these independent variables. But there are many other factors that significantly affect nutritional status which were not included in the study and thus could not be examined for their potential effect on child development. These factors include poverty, large families, limited psychosocial stimulation and low paternal and/or maternal education (El Taguri et al., 2008). Asfaw, Wondaferash, Taha, and Dube (2015) noted that child sex, diarrheal morbidity, fathers' educational status, age at initiation of complementary feeding, number of children ever born to a mother, family planning methods used and pre-lacteal feeding were significantly associated with malnutrition. In their review Surkan, Kennedy, Hurley and Black (2011) observed that maternal depression negatively affects child nutrition, many different studies also noted this effect (Ahmed, Hossain, and Sanin, 2012; Grantham-McGregor et al., 2007; Prado, and Dewey, 2014).

Data entry into WHO Anthro and statistical analysis were conducted by two independent researchers, who afterwards compared and discussed their results. The large sample size is another strength of this study. A limitation of the study is that the nutritional history of the child is unknown. A future study might assign children with different phenotypes of malnutrition to different therapies, according to the developmental delays that were perceived in this study and in others. Performing this investigation with equally distributed groups regarding nutritional status can make it easier to observe the effects of each phenotype of malnutrition.

Conclusion

The purpose of this study was to assess potential correlations between nutritional and developmental status of children aging up to 5 years, living in extreme poverty in Jimma, Ethiopia. We can conclude that there is a negative correlation between nutritional status and the four domains of the Denver II-Jimma. Stunting significantly affected all four developmental domains, while underweight statistically affected the fine motor-adaptive and gross motor domain. Wasting had a significant effect on personal-social skills and language. The findings of this study are important in clinical practice. We observed that the different types of malnutrition affect specific skills in children, other studies found that nutritional rehabilitation combined with treatment aimed at specific skills is necessary for children to recover. In order to provide effective and efficient care, it is imperative to work in a multidisciplinary setting were paediatric physiotherapists, occupational therapists, nurses and other healthcare providers work closely together. This multidisciplinary team should focus on the specific needs of the child, potentially based on the phenotype of malnutrition.

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Ik/wij verlenen het wereldwijde auteursrecht voor de ingediende eindverhandeling:
Correlation between nutritional status and development of children up to 5 years of age, living in extreme poverty

Richting: **master in de revalidatiewetenschappen en de kinesitherapie-revalidatiewetenschappen en kinesitherapie bij musculoskeletale aandoeningen**
Jaar: **2015**

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